Birds, buffers and bicycles: a review and case study of wetland buffers

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Abstract
Wetland buffers separate wetlands from surrounding land uses that are incompatible with wetland values. Buffers are established to fulfil a variety of needs. However, not all functions which are attributed to buffers are mutually compatible. In particular, their use as major recreational zones is not necessarily compatible with reducing disturbance to wetland wildlife, such as birds. This paper examines the buffer around an urban wetland at Altona, Victoria, which is extensively used by recreationists. The presence of a bicycle trail within the buffer might effectively reduce its size and effectiveness, and cause 'buffer creep' whereby the effective separation distance between people and birds is reduced. It might also unintentionally facilitate unauthorised access into an otherwise 'off-limits' wetland. While social support is critical for wetland conservation, the existence of recreation in buffers does not automatically confer high awareness of local wetlands. The success of buffers as a conservation tool will depend upon setting a clear objective for buffers, careful design and management, and evaluation of effectiveness to optimise the potential benefits for wetlands and their fauna. (*The Victorian Naturalist* **126** (3) 2009, 79-86)

Keywords: Buffers, recreation, disturbance, wetlands, birds

Introduction

'Buffers' are zones that are used to separate important remnant or wetland habitat from incompatible land uses. They are used worldwide (Boyd 2001), and in Australia are a prominent feature of urban landscapes where residential and industrial development encroach on important wetland habitat (Western Australian Planning Commission (WAPC) 2005). Buffers are thought to provide benefits both to the adjacent wetland and its biodiversity, and to adjacent residents (see Table 1). In southern Australia, they are typically multiple-use zones, where a variety of human activities and management regimes are permitted or occur. Although various governments provide guidelines for minimum buffer widths (e.g. WAPC 2005), buffers vary greatly; they can be treed or grassed, actively managed (e.g. mown) or unmanaged, large or small. Although buffers are often multiuse zones, not all of the functionalities attributed to buffers are necessarily mutually compatible; for example, recreation may not be compatible with wildlife conservation (see, for example, Banks and Bryant 2007).

Despite being widely used, little is known of the effectiveness of wetland buffers in Australia (Winning 1997). In general, buffer effectiveness increases with increasing width (Castelle *et al.* 1992). However, in reality, space is at a premium in urban areas, and any land dedicated to a buffer needs to be justified. In this paper, we explore aspects of the implementation and performance of buffers from the perspective of their role in wetland wildlife conservation in urban southern Australia. We review the ways in which buffers may help conserve wildlife, and examine a case study to investigate the actual role one buffer plays in protecting an adjacent wetland of international significance to migratory shorebirds. Finally, we highlight some future research and principles that could lead to improved buffer zones.

The role of buffers in wildlife conservation

One key reason for the establishment of buffers is the protection of wildlife. Buffers may help wildlife in three direct ways:

Firstly, buffers are thought to provide additional habitat for wetland species, particularly for species that may rely on adjacent but non-wetland habitat. For example, in Massachusetts, USA, 76% of the 86 species of freshwater wetland-dependent wildlife used wetland buffers and were located at various distances from the edge of the wetland; 52% of species occurred more than 200 feet from the margin of wetlands (Boyd 2001).

Table 1. Reported functions of wetland buffers. This list builds upon functions mentioned by Anon. (1994), Winning (1997), Allan and Walker (2000), Boyd (2001) and Water and Rivers Commission (2001). Benefits are categorised into broad 'types', which may assist other workers with developing a taxonomy of benefits, which is apparently lacking at the present time.

Type of benefit	Benefit conferred to wetland or its biodiversity	Benefit conferred to adjacent residents
Wildlife and wildlife habitat	Provision of habitat and corridors for wildlife, including reducing edge effects	
	Reduced disturbance to wildlife	
	Reduced weed invasion	
	Increased public awareness of wetlands, their wildlife and threats*	
Human-centric	Improved visual amenity	Provision of recreational area
		Reduced nuisance animals
		Fire protection
Water management	Improved water quality (e.g. attenuation of pollutants, excess nutrients and sediments)	Flood mitigation
	Reduced heightened levels of runoff from surrounding areas	Erosion control
	Regulated water temperature	
	Maintenance of water levels (e.g. prevention of ground water drawdown)	
	Prevention of airborne pollutants (e.g. pesticides)	
	Accommodate for 'fuzziness' of wetland boundaries (i.e. allow for expansion in times of flood)	

* Also a benefit to adjacent residents

Secondly, buffers may provide a corridor for wildlife movement, either for wetland-dependent or terrestrial species. While the function of buffers as corridors *per se* is apparently unstudied, corridors are thought to improve connectivity between isolated habitat fragments in a landscape and to facilitate animal movement and dispersal (Beier and Noss 1998; Bennett 2003). Wetland buffers are sometimes contiguous with other wildlife habitat, especially riparian strips, and so represent an opportunity to provide a network of habitat connections between fragmented wetlands (Roe and Georges 2007).

Thirdly, buffers may reduce disturbance. 'Disturbance' is the behavioural or physiological response of an animal to a stimulus, such as a person. Documented impacts of disturbance include: displacement from habitat, such as feeding and breeding areas; exposure of young to predators or diminished parental defence or extreme temperatures; increased conspicuousness to predators; disruption of behavioural displays, such as mating; and increased energy expenditure associated with responses (Weimerskirch *et al.* 2002; Blumstein 2003; Weston and Elgar 2005, 2007; Gill 2007).

Disturbance from human recreational activities is thought to be a key threat to some faunal groups, such as shorebirds (Burger and Gochfeld 1981; Vos *et al.* 1985; Burger and Gochfeld 1991; Fister *et al.* 1992; Weston and Elgar 2005, 2007). Buffers may reduce disturbance to wildlife in three ways:

1. A consistent finding of research into disturbance of wildlife indicates that the intensity and frequency of an animal's response is inversely proportional to the distance between the

stimulus and the animal (Cooke 1980; Rodgers and Smith 1997). Thus, by increasing the distance between people (stimuli) and animals, responses should be less frequent and less intense.
2. By facilitating the repeated presentation of benign stimuli (in this case people) to animals, buffers may underpin learning on the part of the animal whereby responses are reduced (i.e. habituation; Conomy *et al.* 1998).
3. Many buffers in southern Australia are associated with fences, and research suggests fences can decrease the impacts of human disturbance on wildlife (Ikuta and Blumstein 2003).

A Case Study: Cheetham Wetlands, Altona

In 2004 and 2005 the authors conducted a wetland conservation project, using migratory shorebirds as a flagship faunal group, at Cheetham Wetlands, south-west of Melbourne, Victoria. This study has allowed examination of some questions about the role of the buffer around wetlands with respect to wildlife conservation.

The wetlands

Cheetham Wetlands consist largely of artificial lagoons that were constructed for the commercial harvesting of salt during the 1920s (Parks Victoria 2005). The wide variety of wetland habitats available at Cheetham provides feeding, roosting and nesting areas for many species of shorebirds. The area's importance for shorebird conservation has been recognised through its listing as a wetland of international importance under the Ramsar convention (Department of Sustainability and Environment 2003). The site is home to internationally significant populations of the Sharp-tailed Sandpiper *Calidris acuminata* and Curlew Sandpiper *C. ferruginea* as well as populations of state significance of the Black-tailed Godwit *Limosa limosa*, Marsh Sandpiper *Tringa stagnatilis*, Common Greenshank *T. nebularia*, Red-necked Stint *Calidris ruficollis*, Banded Stilt *Cladorhynchus leucocephalus* and Red-necked Avocet *Recurvirostra novaehollandiae* (Watkins 1993; Lane 1997).

The wetlands are located on the western shoreline of Port Phillip Bay, only 20 km from the Melbourne CBD. As such, they are in close proximity to extensive urban development and subject to the many disturbance and degradation processes arising from those areas (Department of Sustainability and Environment 2003). In order to maintain natural values, the wetlands are 'off-limits' to the general public, and a buffer, which hosts a bicycle trail, is maintained between the residences and the wetlands. Parks Victoria (1997), the manager of the wetlands, stated 'a strip of land around the perimeter ... has been identified as a buffer to the environmentally sensitive area. It is proposed that the Bay [bicycle] Trail will be located in this area.' The interface between an area of high natural values and extensive residential development means Cheetham Wetlands are an ideal model for examining wetland buffers.

Buffer creep

The term 'buffer creep' is used to describe the circumstance whereby the effective separation distance between incompatible activities and a wetland is unintentionally shifted in space, while the physical extent of the area designated as the buffer remains the same (see Fig. 1). At Cheetham Wetlands, a sealed, formal bicycle track now runs the length of the buffer, and so the effective separation distance between recreationists and wildlife is decreased; a track down the middle of a buffer would halve the effective buffer distance in terms of protecting wildlife from human disturbance. If it is assumed that there is a consistent tolerance distance of wildlife to humans (Cooke 1980; Rodgers and Smith 1995, 1997), then the effective separation distance has been shifted ('crept') into the wetland. We have no data on whether buffer creep is evident at Cheetham Wetlands or elsewhere, and such studies would be instructive.

Buffer creep may be especially evident where human presence is highly concentrated in space, such as by a formed bicycle track. In Melbourne and many cities around the world, such trails are extensive and expanding, often following watercourses and coastlines (Dill and Carr 2003). At Cheetham Wetlands, the vast majority of recreationists occurred on the bicycle trail, but a substantial minority occurred off the trail on adjacent grassed areas, including some who walked dogs on the side of the buffer nearest the wetlands (pers. obs.).

Do recreationists use the buffer?

As part of our general study of the Cheetham Wetlands (Antos *et al.* 2007), we conducted six hours of observations, in three two-hour blocks, for each of four Sundays (summer

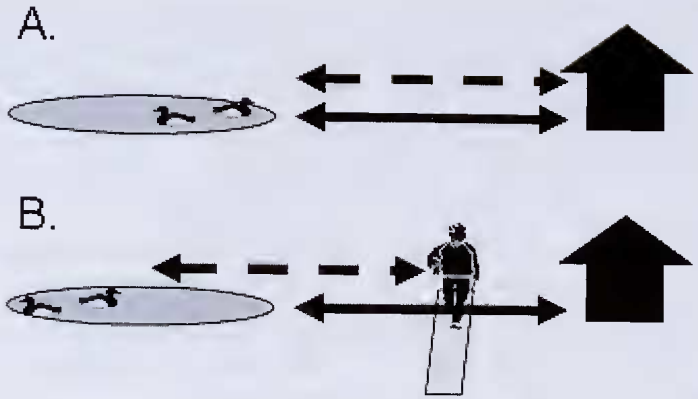

Fig. 1. An illustration of 'buffer creep'. The figure presents two scenarios, a buffer without incompatible activities (A) and a buffer with a recreational path (B). Width of the physical buffer (solid arrows) remains unchanged between scenarios while the effective separation distance between the wetland and incompatible activities (dashed arrow) effectively shifts with the introduction of a recreational path into the buffer. Under scenario B, the buffer has shrunk, but because wildlife response distances probably remain constant, the effective buffer now extends into the wetland.

2004/2005), from a vantage point (37°53'01"S, 144°47'50"E) that enabled a clear view of 1.7 km of the bicycle trail within the buffer to the south west. The furthest point which we could see was where the trail joined the Skeleton Creek trail (37°53'41"S, 144°46'59"E). Binoculars and spotting scopes were used to obtain clear views of all recreationists (refer to Antos *et al.* 2007 for a more detailed description of the site and a site map).

Recreationists used the trail in each of the twelve observation periods (Fig. 2). Overall, 25.6±9.1 (sd) people used the trail each hour. Nearly half (43%) of all recreationists within the buffer were cycling, and a range of other recreational activities also occurred (Fig. 2). These results demonstrate that the buffer is used extensively by recreationists for a variety of activities.

Do recreationists in buffers obey regulations?

Dogs must be leashed in the buffer; however, 68.3% of dogs observed (n = 104) were unleashed. Unleashed dogs are particularly disturbing to birds, including shorebirds (Banks and Bryant 2007; Weston and Elgar 2007). No evidence of dog regulation enforcement was observed during observations.

Trail bikes (off-road motorcycles) are not permitted on the trail, and the local police actively patrolled the bicycle trail with a view to curbing this illegal activity (pers. obs.). Nevertheless, trail bikes occurred on the trail (Fig. 2). Moving rapidly and being noisy, motorised transportation can be potentially highly disturbing to wildlife (see Garcia and Baldassare 2008). It also raises obvious safety concerns for other users of the bicycle path.

The level of compliance may vary in relation to location, education and enforcement activities (Gramann and Bonifield 1995; Solomon 1998; Kasapoglu and Ecevit 2002) but observations suggest many recreationists in buffers do not obey regulations intended to help reduce disturbance to wildlife. The buffer currently has interpretive and regulatory signs, and a variety of education and extension programs have been conducted in the vicinity of the wetlands (Antos *et al.* 2007).

Do buffers facilitate intrusions rather than prevent them?

Currently, the northern half of Cheetham Wetlands has a recreational path through the buffer, and construction of the path through the remainder of the buffer along the southern half of the wetlands has commenced. Antos *et al.* (2007) found that virtually all unauthorised human intrusions into the wetland occurred in the northern half, where the buffer and path bound the wetland. This suggests that the path might facilitate unauthorised access, a contention supported by a number of well-established informal paths leading from the recreational

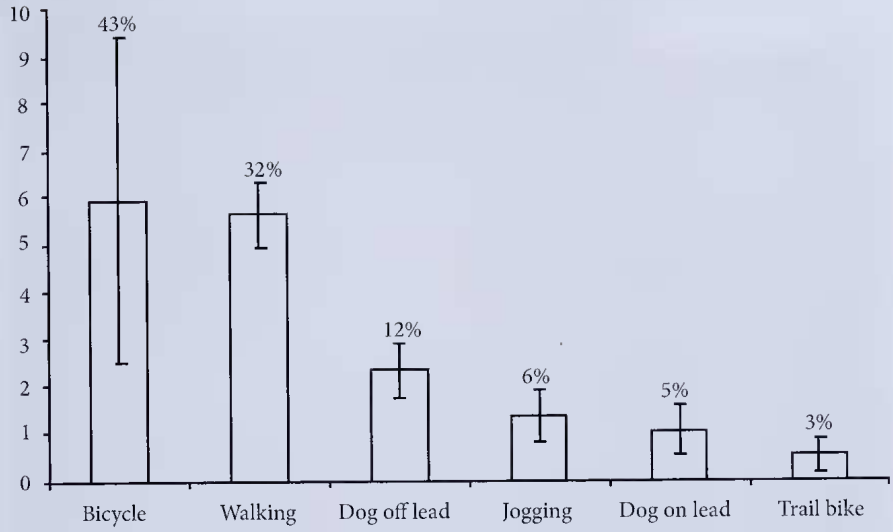

Fig. 2. Mean (± one standard error) number of groups of humans engaged in different recreational pursuits. The figures above the bars indicate the percentage of all humans (n = 614) engaged in different activities.

path, through the boundary fence and into the wetlands (Fig. 3). However, this assertion should be treated with caution because the northern and southern half of Cheetham Wetlands differ in other respects, such as the southern half not currently having abutting residential development.

Does recreation in buffers improve awareness of wetlands?

Human appreciation and understanding of wetlands is crucial to their conservation (Shunula 2002; Bouton and Frederick 2003). Education and awareness play key roles in developing attitudes and appreciation of important habitats like wetlands (McKenzie-Mohr and Smith 1999). It would be interesting to know whether allowing people to access the margins of Cheetham Wetlands had raised their levels of awareness and appreciation of the wetlands. Weston *et al.* (2006) surveyed primary school students at a local school to examine awareness levels of wetlands around Cheetham. They found local wetlands and parks varied dramatically in respect of how well known they were (0-91%). Surprisingly, no students reported awareness of the Cheetham Wetlands despite the fact they were only 200 m away from their school. Most students displayed moderately positive attitudes to wetlands and wetland values. While this study did not directly examine the role that recreational opportunities in the buffer played in awareness among students, it suggests that the presence of recreational opportunities in a buffer does not automatically confer high awareness of significant wetlands.

Towards better buffers

Buffers have the potential to provide protection for wetlands and their biodiversity from adjoining land uses, provided they are well-planned and appropriately managed. However, their performance is little studied, especially in view of their multiple functions (Winning 1997). We suggest that two steps could improve the effectiveness of buffers:

1. Higher specificity of management goals of buffers would aid their design and implementation, and avoid unwanted generality or ambiguity with respect to their objectives (Castelle *et al.* 1992). Specifically, we suggest the proposed role of the buffer in the conservation of wildlife should be stated explicitly as one or a combination of: (a) provision of habitat, (b) provision of corridors and/or (c) reduction of disturbance. Each goal potentially engenders

Fig. 3. A well-established unauthorised path leading from the bicycle trail, through the boundary fence into Cheetham Wetlands, Altona, Victoria. Photo by MA Weston.

different buffer designs, management, and balance between recreational and wildlife needs. The management of buffers should reflect their identified roles.

2. Research that addresses key questions about buffer design and management is needed. The optimal design of buffers intended to provide habitat and corridors would usefully draw from the body of research on landscape ecology and reserve system design (e.g. Beier and Noss 1998; Cabeza and Moilanen 2001). Buffers to minimise disturbance could utilise Flight Initiation Distances, which are currently available from overseas (Blumstein *et al.* 2003), but are largely unavailable for Australian wetland birds. The determination of buffer widths should also account for the specific objective of a buffer (Castelle *et al.* 1992; Allan and Walker 2000) and for fluctuating water levels (WAPC 2005).
3. The creation of ecologically meaningful guidelines for the establishment of buffers is imperative if they are to fulfil the role of enhancing nature conservation. Such guidelines should be informed by appropriate science, much of which is not yet available, especially in the Australian context. Students of ecology, conservation biology and environmental management are encouraged to better investigate the strengths, weaknesses and opportunities that buffers present for the conservation of wildlife and habitat, by conducting studies that provide results that are readily available for use by planners and managers. The monitoring of the effectiveness of established buffers and a willingness to engage in adaptive management to ensure they fulfil their designated roles is also desirable.

Acknowledgments

The Cheetham Wetlands project, including all data collection, was conducted by Birds Australia, and funded by the Australian Government's Natural Heritage Trust and Price Waterhouse Coopers, and managed by WWF Australia. We thank the Parks Victoria rangers at the Cheetham Wetlands, especially Bernie McCarrick and John Argote, for their time and generous assistance with our research. Bianca Priest, Glenn Ehmke and Chris Tzaros all provided valuable input into the Cheetham Wetlands Project for which we are grateful. This paper was given at the FNCV Biodiversity Symposium on urban birds (September 2008), and emphasises the need for buffers for wetland birds in the Melbourne area. It intends no criticism of management at Cheetham Wetlands.

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Received 20 November 2008; accepted 12 March 2009

Red-necked stints *Callidris ruficollis*. Photo by MA Weston

The presence of a human causes the shorebirds to flush. Photo by MA Weston